Origami for Robotics and Active Mechanical Haptics

Hanqing Jiang*[1]

[1]Westlake University [Zhejiang] – China

Abstract

The capability of stiffness manipulation for materials and structures is essential for tuning motion, saving energy, and delivering high power. However, high-efficiency in situ stiffness manipulation has not yet been successfully achieved despite many studies from different perspectives. In the first half of this talk, we will present curved origami patterns to accomplish in situ stiffness manipulation covering positive, zero, and negative stiffness by activating predefined creases on one curved origami pattern. This elegant design enables in situ stiffness switching in lightweight and space-saving applications, as demonstrated through three robotic-related components. Then in the second half of this talk, we will present a first-person, human-triggered haptic device enabled by curved origami that allows humans to actively experience touching of objects with various stiffness perceptions from soft to hard and from positive to negative ranges. This new device represents a significant shift away from third-person, machine-triggered, and passive haptics currently in practice. The device is synchronized with the virtual environment by changing its configuration to adapt various interactions by emulating body-centered physical perceptions, including hardness, softness, and sensations of crushing and weightlessness. The high-fidelity stiffness perceptions achieve an unprecedented experience of "what a user sees or is immersed in, is what the user feels or steps on".

*Speaker